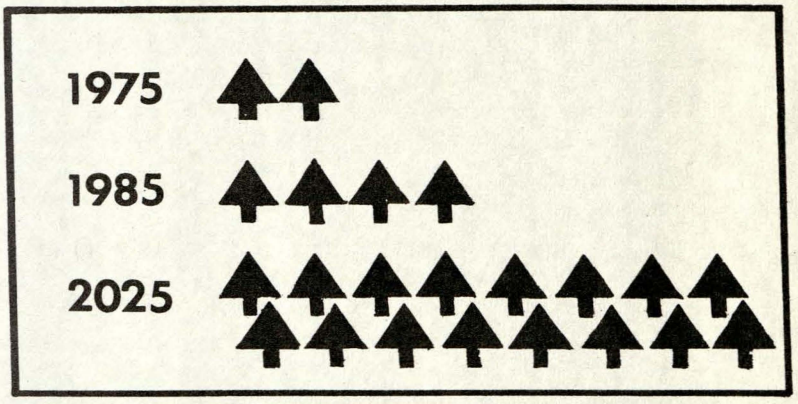
)A FOREST SERVICE
IERAL TECHNICAL REPORT NC-19

a case study showing potential supplies of red pine awtimber

thomas c. marcin
darrell m. frogness



NORTH CENTRAL FOREST EXPERIMENT STATION
FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

CONTENTS

Present Situation on the Chippewa National Forest 2

Methods 2

Management Alternatives 4

Results 7

Conclusion. 7

THE AUTHORS: Thomas C. Marcin is an Economist for the North Central Forest Experiment Station at its headquarters laboratory in St. Paul, Minnesota. Darrell M. Frogness is a Forester for the Chippewa National Forest in Minnesota.

North Central Forest Experiment Station
John H. Ohman, Director
Forest Service - U.S. Department of Agriculture
Folwell Avenue
St. Paul, Minnesota 55101

1975

A CASE STUDY SHOWING POTENTIAL SUPPLIES OF RED PINE SAWTIMBER IN THE LAKE STATES

Thomas C. Marcin and Darrell M. Frogness

Supplies of red pine sawtimber could ncrease twentyfold throughout the Lake tates during the next 50 years. In Michi- an, more than 500,000 out of 600,000 acres f red pine type were less than 40 years ld in 1966. In Wisconsin, 85 percent of he 310,000 acres of red pine were less han 40 years old in 1968. In Minnesota, nly 87,000 acres of 284,000 acres of red ine were less than 40 years old in 1962. owever, 40,000 acres of red pine type were lanted on the two national forests alone n Minnesota between 1962 and 1972, which ndicates that substantial areas of new ed pine stands now are growing in the tate.

The potential long-term sawtimber roduction from Lake States red pine could e at least 500 MMfbm (million board feet) year if these young stands are managed sing proper thinning schedules. Total nnual cuts of red pine for the three tates presently range between 25 to 30 Mfbm. Although such an increase might ot be significant nationally, it certainly ould be regionally.

Therefore, long-range planning to nsure maximum development of this timber esource in the future is needed now using omputerized methods already available. ne of these is Timber RAM, which is a ethod for choosing an optional schedule f management treatments (Navon 1971).[1]

[1] *Daniel I. Navon. Timber RAM--a long-ange planning method for commercial timber ands under multiple-use management. USDA or. Serv. Res. Pap. PSW-70, 22 p., illus. ac. Southwest For. and Range Exp. Stn., erkeley, Calif. 1971.*

Using Timber RAM the land manager can develop information needed for making decisions that are responsive to changing conditions. For example, if another shortage of softwood timber develops when housing construction rebounds, he could readily examine the long-term effects of an immediate short-term increase in timber cut.

The purpose of this report is to illustrate how Timber RAM was used to determine the potential timber supply of red pine sawtimber available on the Chippewa National Forest in northern Minnesota for the next 50 years at the three levels of management shown below.

Alternative 1--Low-intensity management.

1. Maintain old-aged stands.
2. Convert 11,200 acres to red pine in the next decade to maintain a base of 66,300 acres in red pine.
3. Cut 41 MMfbm of red pine in decade 1.

Alternative 2--Medium-intensity management.

1. Cut some old-aged stands in decade 1.
2. Convert 11,200 acres to red pine in decade 1; 10,000 acres in decades 2 and 3 to maintain a base of 86,300 acres of red pine.
3. Cut 60 MMfbm of red pine in decade 1.

Alternative 3--High-intensity management.

1. Cut old-aged stands in decade 1 and decade 2.
2. Convert 15,000 acres to red pine in decade 1, decade 2, and decade 3 to

maintain a base of 101,100 acres of red pine.

3. Cut 88 MMfbm of red pine in decade 1.

PRESENT SITUATION ON THE CHIPPEWA NATIONAL FOREST

In the 1970 inventory, 55,113 acres (10 percent) of the regulated commercial forest lands on the Chippewa National Forest were classified as red pine type. Of these, approximately 25 percent were in stands less than 10 years old (fig. 1).

This can be attributed to a planting program that has been in operation since the late 1940's, which produced increases in the red pine type of almost 10,000 acres between 1948 and 1960 and of an additional 13,000 acres between 1960 and 1970. This program is expected to continue: an additional 11,200 acres are expected to be planted between 1970 and 1980 and 10,000 acres in the 1980's and in the 1990's. As a result, growing stock, which increased from 47.5 MMft^3 in 1960 to 70 MMft^3 in 1970, is expected to continue to increase as the new plantations and second-growth natural stands mature.

In 1970, the volume of red pine within the red pine type only was estimated to be 275 Mfbm and the total volume of red pine in all timber types to be 354 Mfbm. Between fiscal years 1964-1973, timber sales of red pine and some white pine averaged 4,454 Mfbm annually while annual cut averaged 4,145 Mfbm. In the same period the average sale price doubled--from $26.01 to $52.91/Mfbm.

Even though the aspen type currently covers 37 percent of the commercial forest lands, red and white pine sawtimber provide the greatest single source of stumpage revenue. In fiscal year 1973, revenues from red and white pine sawtimber were $290,107 as compared with $100,000 from aspen.

METHODS

In our projections, we didn't attempt to delete the red pine type growing in travel and water influence zones because inventory data were only available on a forest-wide basis. Furthermore, the acreage of red pine type growing in such zones is so small that it wouldn't significantly affect our projections.

The area of red pine type was subdivided into the 10 age classes, 2 site classes, and 3 stocking classes shown in table 1. Twenty-nine timber classes were defined from these site-stocking-age combinations. For these timber classes, average stand condition was estimated for projection of volume yields. These conditions are summarized in table 2, in which a three-letter code is assigned for the Timber RAM program.

To project volume yields for each timber class, a set of management activities must be specified for the RAM program. We assumed that the red pine stands would be thinned every 10 years to 90 ft^2 of basal area. In addition the RAM special-activity option was used for the 902 acres of mature medium-stocked red pine type scheduled to be harvested during decade 1 (1972-1982). We added the estimated volume of red pine from other types to the harvest volume from these 902 acres in our projections for this first decade.

We projected red pine yields using a computerized stand growth simulator[2] developed by Lundgren. This model is based on growth analyses of data from the Chippewa National Forest by Wambach (1967)[3] and Buckman (1962).[4]

Yields for future plantations were estimated using alternative levels of initial plantings ranging from 400 to 1,200 trees/acre and of thinnings to residual stands varying from 60 to 120 ft^2 of basal area. We found that an average of 600 surviving trees/acre thinned to a residual of 90 ft^2 of basal area approximated maximum growth for a wide variety of conditions. We reduced the yields projected by the model to 20 percent because the model only accounts for tree mortality caused by crowding (i.e. excessive density).

---

[2] *This model is called REDPINE. It was developed by Dr. A. L. Lundgren, Principal Economist, North Central Forest Experiment Station, St. Paul, Minnesota.*

[3] *Robert F. Wambach. A silvicultural and economic appraisal of initial spacing in red pine. Ph.D. dissertation available from University Microfilms, Inc., Ann Arbor, Mich. 282 p. 1967.*

[4] *Robert E. Buckman. Growth and yield of red pine in Minnesota. USDA For. Serv., Tech. Bull. 1272, 50 p. North Cent. For. Exp. Stn., St. Paul, Minn. 1962.*

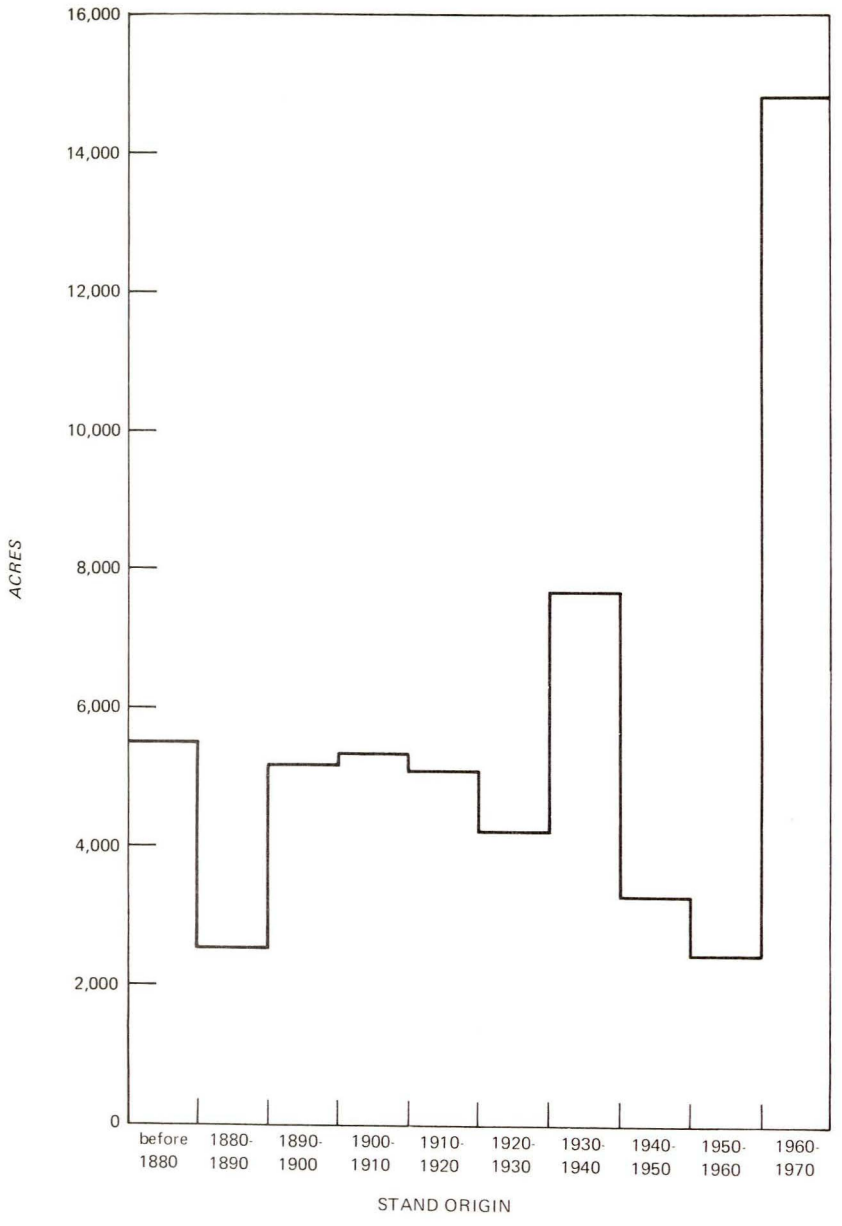


Figure 1.--*Area of red pine type by year of origin, Chippewa National Forest, 1970.*

Table 1.--*Chippewa National Forest 1970 inventory area for red pine type by age, stocking, and site index*

(In acres)

Age	Stocking						Total
	Poor[1]	Medium[2]	Good[3]	Poor[1]	Medium[2]	Good[3]	
	Site index ≤ 65			Site index > 65			
90+		902	4,633				5,535
80-89		478	1,800				2,278
70-79	159		5,021				5,180
60-69		683	2,899			1,263	5,345
50-59	601	891	2,827	151	604		5,074
40-49	326	777	3,108				4,211
30-39			3,843		879	2,946	7,668
20-29		600	2,075		571		3,246
10-19		1,059	792			567	2,418
0- 9		1,366	7,258			6,034	14,658
Total	1,086	6,756	34,256	151	2,054	10,810	55,113

[1]Basal area range < 40 ft.
[2]Basal area ≥ 40 ft^2 to < 80 ft^2.
[3]Basal area ≥ 80 ft^2.

Yield information is entered into the RAM program by means of volume yield tables. Therefore, for simplicity, we limited our input to the six model stands shown in table 3. These stands characterize those found on the Chippewa National Forest.

MANAGEMENT ALTERNATIVES

Because of its stable growth characteristics, red pine can be managed for a wide range of stand conditions and stand ages. Although rotation ages of 80 to 100 years often are recommended for sawtimber production from red pine plantations, red pine stands still continue to grow well up to, or beyond, 150 years. Thus, there are many acceptable management regimes for red pine.

However, our three alternatives were based on the following assumptions. Beginning at about age 30, red pine stands would be thinned every 10 years to 90 ft^2 of basal area and would be allowed to reach 150 years of age. New plantations would average 600 surviving trees/acre and would be managed on a 90-year rotation. At age 90, stands managed under this regime will average 17 in. d.b.h. for site index 55 and 23 in. d.b.h. for site index 70.

However, larger trees could be produced at lower densities if stands were managed at lower densities. For example, thinning to 60 ft^2 of basal area on site index 55 would yield trees of 20 in. d.b.h. at age 90. Because volume control based on intermediate and harvest cuts is used for managing existing stands, the rotation age assumption only indirectly affects their management.

However, harvest levels can be constrained using either area or volume control. In general, however, some amount of constraint by area is desirable to achieve a balanced age-class distribution of forest types for diverse wildlife habitat and to maintain a sustained orderly flow of timber from the forest. National forests in the Lake States have been managed using area control to produce a regulated, balanced distribution of age classes after one rotation.

We used volume control because it enabled us to limit the fluctuation of harvest volumes between decades based upon future volume estimates of timber from intermediate and harvest cuts.

Each of our alternatives offers an increasing level of future harvest having the long-range sustained average cuts shown in

figure 2. The projected long-range sustained yield averages per decade are 293 MMfbm for alternative 1, 386 MMfbm for alternative 2, and 450 MMfbm for alternative 3.

Table 2.--*Timber class characteristics and estimated stand conditions used to estimate red pine yields on the Chippewa National Forest*

RAM Timber class code	Timber class characteristics			Average stand conditions	
	Average age in 1975	Average site index	Stocking class[1]	Basal area	Trees/acre
				Ft²	*Number*
RAA	110	55	Good	100	120
RAB	110	55	Medium	60	70
R9A	90	55	Good	100	150
R9B	90	55	Medium	60	90
R8A	80	55	Good	100	170
R8C	80	55	Poor	30	50
R7A	70	55	Good	100	220
R7B	70	55	Medium	60	130
R7D	70	70	Good	100	140
R6A	60	55	Good	100	270
R6B	60	55	Medium	60	160
R6C	60	55	Poor	30	80
R6E	60	70	Medium	60	100
R6F	60	70	Poor	30	50
R5A	50	55	Good	100	370
R5B	50	55	Medium	60	220
R5C	50	55	Poor	30	110
R4A	40	55	Good	100	600
R4D	40	70	Good	100	350
R4E	40	70	Medium	60	210
R3A[2]	30	55	Good		
R3B[2]	30	55	Medium		
R3E[2]	30	70	Medium		
R2A[2]	20	55	Good		
R2B[2]	20	55	Medium		
R2D[2]	20	70	Good		
R1A[2]	10	55	Good		
R1B[2]	10	55	Medium		
R1D[2]	10	70	Good		

[1]Good $\geq$ 80 ft^2 of residual basal area; medium $\geq$ 40 ft^2 to < 80 ft^2; and poor < 40 ft^2.

[2]These were assumed to be plantation stands having an average of 600 trees/acre. (For stands 30 years or younger, basal area is not considered important.)

Table 3.--*Red pine volume yields with 20 percent reduction for model stands thinned every 10 years to 90 ft² of basal area*

(In thousand board feet)[1]

Age	Volume before thinning	Thinning volume
WELL-STOCKED, SITE INDEX 55, OLD-AGED STANDS		
110	17.0	1.7
120	20.5	3.6
130	21.7	3.3
140	22.7	3.3
150	23.7	3.1
POORLY STOCKED, SITE INDEX 55, MIDDLE-AGED STANDS		
80	3.3	0
90	6.2	0
100	10.0	0
110	14.2	0
120	18.5	1.7
130	21.0	3.2
140	21.5	3.1
150	21.8	
WELL-STOCKED, SITE INDEX 55, MIDDLE-AGED STANDS		
60	3.0	1.0
70	9.1	2.6
80	14.4	3.9
90	16.5	3.9
100	18.5	4.0
110	19.3	3.6
120	20.3	3.5
130	20.8	3.1
140	21.4	3.1
150	21.7	
WELL-STOCKED, SITE INDEX 70, MIDDLE-AGED STANDS		
70	12.7	1.3
80	21.1	6.7
90	24.1	7.3
100	26.0	7.1
110	27.8	7.1
120	29.1	6.7
130	30.4	6.0
140	30.3	5.5
150	29.9	
WELL-STOCKED, SITE INDEX 55, PLANTATION		
40	0	0
50	3.7	1.3
60	10.7	3.4
70	15.1	4.4
80	17.6	4.7
90	19.3	4.6
100	20.6	4.5
110	21.4	4.0
120	22.1	3.9
130	22.6	3.4
140	22.8	3.3
150	22.7	
WELL-STOCKED, SITE INDEX 70, PLANTATION		
40	3.8	1.6
50	14.7	5.8
60	20.2	7.4
70	24.1	8.3
80	26.2	8.1
90	27.3	7.1
100	28.8	6.7
110	28.7	5.6
120	28.2	5.0
130	29.0	4.6
140	29.0	4.2
150	29.0	

[1]International ¼-inch rule.

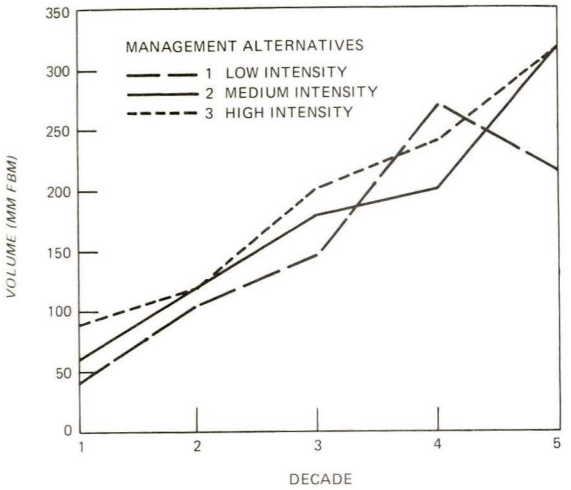


Figure 2.--*Projections of total sawtimber volume cut from the Chippewa National Forest per decade for three management alternatives.*

RESULTS

Under alternative 1, total harvest volume could increase to over 200 MMfbm, almost all of which would be derived from thinnings (table 4). This is based on an annual cut of about 41 MMfbm for the period 1964-1973. Under alternative 2 total harvest volume could be increased from 60 MMfbm in the next decade to over 300 MMfbm in decade 5, most of which would also be derived from thinnings for alternative 2 level management. Under alternative 3, 88.3 MMfbm could be cut in decade 1 if harvest cuts could be accelerated.

To approximate large and small saw log size material, we divided total saw log volume into: (a) cuts from stands under 80 years old, and (b) cuts from stands 80 years and older. All three alternatives will provide an increasing supply of saw logs from stands 80 years and older as shown in figure 3.

The average ages at which harvest or regeneration cuts would be made are shown in table 5. All would be over 100 years for the 5 decades even under management alternative 3. Under alternative 2, a relatively uniform area of regeneration cuts in existing stands could be maintained until younger plantations reach maturity. Furthermore, the average age at harvest would be increased to over 130 years after the second decade. It would decrease during the fifth decade.

Under alternative 1, stands would be maintained until they are 150 years old and the existing 4,633 acres of old-age stands would be cut in the fourth decade. Only 90 acres a year would be harvest cut and regenerated during the first decade; none during the following two decades.

At the other extreme, alternative 3 cutting of existing stands would be accelerated; harvest cuts varying from 1,546 acres in the second decade to 9,334 acres in decade 5 would be scheduled. Existing stands would be harvested as soon as younger plantations are available, which would forestall a fall off in total volume cut.

Under alternative 2, harvest cuts would range from about 1,200 acres in decade 2 to nearly 2,400 acres in decade 4 and 6,224 acres are scheduled for cut as younger stands reach maturity in decade 5.

CONCLUSION

The present allowable cut for the Chippewa National Forest could be doubled in the next decade to 8.8 MMfbm a year while maintaining a steady increase in allowable cut for the next 50 years to a level of 30 MMfbm annually.

Much of the increased cut will come from thinnings because over one-half of the red pine type on the Forest in 1970 was under 40 years of age. Thinnings alone would produce an average of about 10 MMfbm a year in the 1990's, if thinnings are made every 10 years. Consequently, a significant opportunity exists in the next 50 years for expansion and development of timber industries in the market area of this Forest.

Table 4.--*Illustrative projections of future red pine sawtimber supplies for three alternative management levels*

Period (decades)	Thinning: Area (Acres)	Thinning: Volume *MM fbm*[1]	Harvest cuts: Area (Acres)	Harvest cuts: Volume *MM fbm*[1]	Total Volume *MM fbm*[1]
ALTERNATIVE 1--LOW-INTENSITY MANAGEMENT					
1	[2]21,389	31.7	902	9.4	41.1
2	32,745	105.0	0	0	105.0
3	37,065	144.8	0	0	144.8
4	40,795	164.6	4,633	105.2	269.8
5	54,078	215.3	0	0	215.3
ALTERNATIVE 2--MEDIUM-INTENSITY MANAGEMENT					
1	[2]20,082	29.1	2,209	30.9	60.0
2	30,241	95.5	1,198	24.5	120.0
3	32,179	128.3	2,381	51.7	180.0
4	38,532	157.5	2,010	42.5	200.0
5	45,063	184.8	6,752	135.2	320.0
ALTERNATIVE 3--HIGH-INTENSITY MANAGEMENT					
1	[2]18,302	26.4	3,989	61.9	88.3
2	28,112	88.3	1,546	31.7	120.0
3	28,139	113.1	4,771	86.9	200.0
4	30,006	125.4	6,177	114.6	240.0
5	35,296	136.9	9,334	183.1	320.0

[1]International ¼-inch rule.

[2]Actual prescribed thinnings were 10,880 acres in decade 1. For simplicity in the RAM program, it was assumed that all stands with good stocking would be thinned from an average of 100 ft^2 of basal area to 90 ft^2. In practice, one-half that number were probably thinned from 110 ft^2 of basal area to 90 ft^2.

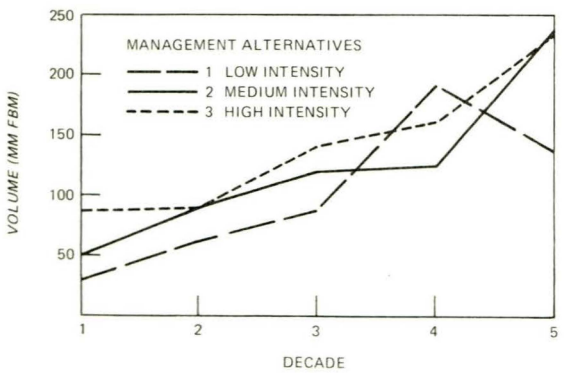


Figure 3.--*Projections of red pine sawtimber cut from the Chippewa National Forest per decade from stands 80 years and older for three management alternatives.*

Table 5.--*Average age of stands at harvest for the three management alternatives*

Decade	Management alternatives: Low-intensity	Management alternatives: Medium-intensity	Management alternatives: High-intensity
1	110	98	110
2	--	120	120
3	--	130	105
4	150	136	104
5	--	133	100

☆U.S. GOVERNMENT PRINTING OFFICE: 1975—668-480/75

Marcin, Thomas C., and Darrell M. Frogness.
1975. A case study showing potential supplies of red pine sawtimber in the Lake States. USDA For. Serv. Gen. Tech. Rep. NC-19, 8 p., illus. North Cent. For. Exp. Stn., St. Paul, Minn.

Red pine sawtimber supplies will increase significantly in the Lake States in the next 50 years as young stands established since the 1930's mature. The long-range effects of this increase for the Chippewa National Forest in northern Minnesota are analyzed using Timber RAM. Red pine sawtimber cut may increase eightfold in the next 50 years for the Forest.

OXFORD: 624:721.1:792(776)174.7. *Pinus resinosa.*
KEY WORDS: Timber RAM, long-range planning, economics.

Marcin, Thomas C., and Darrell M. Frogness.
1975. A case study showing potential supplies of red pine sawtimber in the Lake States. USDA For. Serv. Gen. Tech. Rep. NC-19, 8 p., illus. North Cent. For. Exp. Stn., St. Paul, Minn.

Red pine sawtimber supplies will increase significantly in the Lake States in the next 50 years as young stands established since the 1930's mature. The long-range effects of this increase for the Chippewa National Forest in northern Minnesota are analyzed using Timber RAM. Red pine sawtimber cut may increase eightfold in the next 50 years for the Forest.

OXFORD: 624:721.1:792(776)174.7. *Pinus resinosa.*
KEY WORDS: Timber RAM, long-range planning, economics.

AMERICAN REVOLUTION BICENTENNIAL
1776-1976